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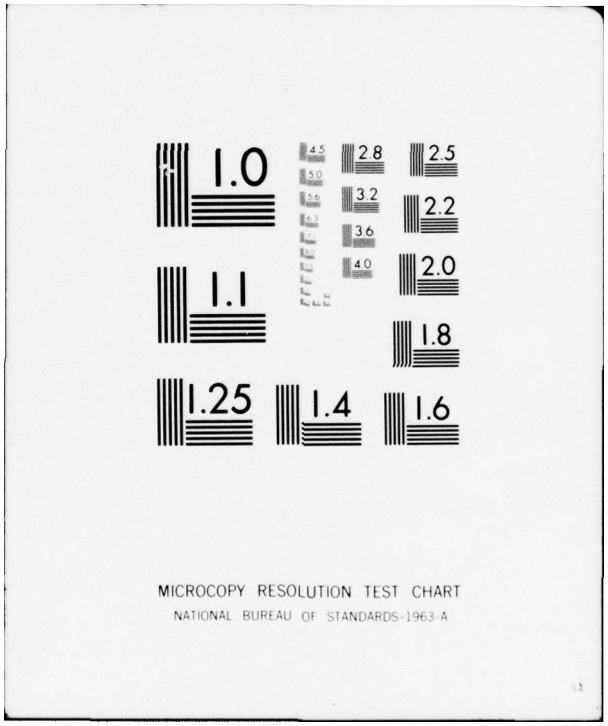
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DEFENSE SYSTEMS MANAGEMENT SCHOOL

Program Management Course

Student Study Program

THE CONTRACTUAL ASPECTS OF
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STUDY REPORT
PMC 73-2

Joseph A. Kralovec
Major USAF

Fort Belvoir, Virginia 22060

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE: CONTRACTUAL ASPECT OF DESIGN-TO-COST ON THE A-10 PROGRAM

STUDY PROBLEM/QUESTION: To examine the contractual features of applying the concept of design-to-cost on a major weapon system procurement.

STUDY REPORT ABSTRACT:

Design-to-cost was originated by the DOD. It has been further defined and explained by numerous officials in an effort to make cost the primary consideration in the acquisition of products for the DOD. This report is an explanation of the contractual application of design-to-cost in acquiring the A-10 air vehicle during its full scale development phase. The design-to-cost clause and related clauses in the prime contract were examined in detail with strong points and weaknesses brought out. Few problems with contractually applying design-to-cost were uncovered.

KEY WORDS: MATERIEL DESIGN AND DEVELOPMENT DESIGN-to-COST CONTRACT ADMINISTRATION REQUESTS FOR PROPOSALS ACQUISITION AIRCRAFT COST CONTROL PROJECT MANAGEMENT

Student, Rank Service	Class	Date
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THE CONTRACTUAL ASPECTS OF DESIGN-TO-COST ON THE A-10 PROGRAM

An Executive Summary
of a
Study Report
by

Joseph A. Kralovec
Major USAF

November 1973

Defense Systems Management School
Program Management Course
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Fort Belvoir, Virginia 22060

EXECUTIVE SUMMARY

Design-to-cost was originated within the Department of Defense (DOD) over two years ago. Officials have been explaining ever since then just how this discipline would be applied in systems acquisition. The Joint Logistics Commanders have recently agreed upon a pamphlet which explains the three services approach to implementing design-to-cost.

Using this pamphlet as a basis for common terminology, the contractual application of design-to-cost on the A-10 program was examined. This program was chosen for examination, since it is considered to be a model for future contractual applications.

The contractual aspects of the program were examined in general, then the design-to-cost provisions were discussed in detail. Each element of the design-to-cost goal was explained concerning its significance and weakness. Constant year dollars, production quantities, production rate and unit cost all have an effect.

Other major clauses were examined concerning their specific interplay with the design-to-cost clause. Cost reporting is an essential supporting contractual requirement. Although an award fee clause is included in the prime contract, it has little affect on the design-to-cost features.

The only incentive to meet the design-to-cost goals is

continuation of the program. At specified demonstration milestones, the prime contractor must demonstrate his ability to meet these goals. If the demonstration is not satisfactory, the program could be cancelled.

As one of the initial programs including design-to-cost, the A-10 program appears to have a noteworthy contractual approach.

THE CONTRACTUAL ASPECTS OF DESIGN-TO-COST ON THE A-10 PROGRAM

STUDY REPORT

Presented to the Faculty
of the
Defense Systems Management School
in Partial Fulfillment of the
Program Management Course
Class 73-2

by

Joseph A. Kralovec
Major USAF

November 1973

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The key to the successful research for this study was obtaining access to the contracts for the major subsystems of the A-10. Assistance in this regard along with several interview sessions was provided by Mr. Joseph Michaelly, Directorate of Procurement Operations, DCS/Procurement and Production, Headquarters Air Force Systems Command.

Assistance was also obtained in clarifying facts from Major M. J. Waite, Directorate of Procurement Policy, Headquarters United States Air Force.

Discussions with various personnel from the A-10 Systems Program Office, Aeronautical Systems Division, Air Force Systems Command and contractor personnel added some insights to already gathered facts.

Finally, the council and constructive suggestions by Mr. Al Moore, my study advisor, helped to make the preparation of this report educational for me rather than the completion of a requirement.

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THE CONTRACTUAL ASPECTS OF DESIGN-TO-COST ON THE A-10 PROGRAM *

Introduction

By now, design-to-cost has become a widely discussed term within the Department of Defense (DOD) and the defense industry community. In the past two years, this concept has received considerable high level attention. The primary concern of most managers was to determine just what was meant by this term and how it could be used.

The concept of design-to-cost resulted from the awareness by officials within the Office of the Secretary of Defense (OSD) that the costs of new systems purchased for the DOD were skyrocketing. New management tools were required to control costs. A wide spectrum of costs would have to be considered along with schedule and technical performance in determining which systems the DOD could afford to buy. Affordability had become a predominate factor in major decisions to cancel or continue programs.

OSD documented their new system acquisition policies in July 1971. Concepts such as technical milestoning, use of cost type

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*ABSTAINER

This study represents the views and conclusions of the author and does not necessarily reflect the official opinion of the Defense Systems Management School nor the Department of Defense.

contracts for development and fixed price contracts for production and prototyping were given new emphasis. Design-to-cost was originated within the DOD by the following excerpt from DOD Directive 5000.1:

> Cost parameters shall be established which consider the cost of acquisition and ownership; discrete cost elements (e.g., unit production cost, operating and support cost) shall be translated into "design to" requirements. System development shall be continuously evaluated against these requirements with the same rigor as that applied to technical requirements. Practical tradeoffs shall be made between system capability, cost and schedule. Traceability of estimates and costing factors, including those for economic escalation, shall be maintained.

Even though the OSD directive included operating and support costs as part of the "design to" requirements only unit production costs have been considered feasible to include in design-to-cost goals established thus far. While design-to-cost is a handy way of grabbing hold of the production cost of a unit, DOD does not yet know how to deal with costs of operation and maintenance that occur further out in the system life cycle. Support costs are grouped in such broad cost categories that identification by weapon system is very difficult at this time. Therefore, it was decided within the OSD to concentrate initially on the control of unit production costs.[1]

It is of interest to note that for some time "a major design goal of Soviet weapons systems has been simplicity and ruggedness

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[1]Dr John S. Foster Jr., DDR&E Views on Design-to-a-Cost, Design-to-a-Cost Symposium, Boeing Company, Seattle, Washington, November, 1972, p.3.

with design for ease of operation and maintenance."[2] Many commercial manufacturers have emphasized design simplicity and unit production cost control for some time. The DOD seems to be getting in step with others who already practice some form of conservatism in their product designs.

WHAT IS DESIGN-TO-COST

Design-to-cost is nothing more than a process utilizing unit cost goals as thresholds for managers and as design parameters for engineers within the contractors organization and the government program office. The Defense Systems Acquisition Review Council (DSARC) recommends approval of a single cumulative average unit flyaway cost for a program. This cost goal becomes binding upon the service program manager (PM) when the Secretary of Defense approves the Development Concept Paper (DCP) for that program. It is incumbent upon the PM to include the appropriate cost goals in the program contracts.[3]

This cost goal has its most effective influence upon the design and management of a program if it is established at the earliest possible date in the acquisition cycle. Under current procedures, this would be at the first DSARC meeting, when the decision is made to proceed into the Validation Phase. It is less effective, but

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[2]Dr. L.A. Mounter, "Soviet Design Philosophy -- Research and Its Impact on Weapon Systems Development," Army Research and Development News Magazine, Vol 14, No. 5 (September-October 1973), p.14.

[3]Joint Design-to-Cost Guide: A Conceptual Approach for Major Weapon System Acquisition, Air Force Systems Command Phamphlet 800-19 (Draft), Department of the Air Force, September 24, 1973, p.3.

still acceptable to OSD, if it is established at the second DSARC meeting, when the full scale development decision is made. If it is established early in the acquisition cycle, a revision may be required when the PM comes before the second DSARC meeting.

Depending upon the characteristics of the particular program, the PM may track the average unit flyaway cost as a program office goal or assign it to the prime integrating contractor as one of their management goals. Regardless of who tracks the average unit flyaway cost, it can be broken down into smaller subsystem goals called unit production costs. These unit production cost goals should be determined by the program office, probably through the negotiation process with the contractor, for each subsystem. Subcontractors and in-house sources for particular subsystems should be assigned unit production goals for their contribution to the total system.[4]

The dollar value for each of these goals represents what the Secretary of Defense and the cognizant service, in turn, have established as an amount they are willing and able to pay for a unit of military equipment or a subsystem. Each subsystem and the total system must meet measurable performance requirements individually or as a package depending on the particular contract terms and conditions. A specified production quantity and rate during a specified period of time are also part of each unit flyaway and unit production cost goal.[5]

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[4]Ibid

[5]Ibid

A major key to the success of the design-to-cost concept is the ability of the PM and contractor to trade-off performance requirements to achieve cost goals. The unit production cost must be related to an economical production schedule including quantity and rate and only the minimum number of essential performance requirements. This approach will allow the flexibility needed to make trade-offs among cost, schedule and performance including maintainability and reliability. Design of the product must be an iterative process to meet the cost, schedule and performance contractual requirements. Desired performance may be degraded to some extent in order to achieve the desired cost goal while assuring that a viable system design is obtained.[6]

It is important to keep in mind that adequate and timely research and development dollars must be available to redesign subsystems and components to solve design problems that threaten achievement of the unit production cost goals and the flyaway cost goal. Spending additional research and development money in the early program years should result in lowering the production cost and possibly even the operation and maintenance costs so that the total program cost can be maintained at or lower than the goal included in the program DCP. It is this assumption that motivates the DOD to emphasize design-to-cost.

Unit cost goals used in the contract include only those costs which are related to the production of components or subsystems of

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[6]Ibid

the total system. Related costs for additional support hardware, training, initial spares, data and program management are normally required by the statement of work in the contract. However, these related costs are not considered to be part of the unit cost goals. Costs of recurring materials, purchased parts, labor and overhead associated with the unit production cost are included in the design-to-cost goals. Non-recurring costs like production tooling are also quite often included as an intergral part of the goals.

This examination of just what is meant by design-to-cost is essential if the concept is to be applied to the acquisition of a DOD system. Contractual use of this technique to date has veried from program to program and among the services. The contractual application must complement the engineering design aspects in order for it to be an effective management tool. The A-10 program, which is managed by a "super SPO" (System Program Office) within the Aeronautical Systems Division of the Air Force Systems Command, is considered to be a good example of the application of design-to-cost on a major system acquisition.[7]

GENERAL PROGRAM FEATURES

There are four primary subsystems of the A-10 that are contracted for and affect the design-to-cost provisions of the entire weapon system. Three of these subsystems are being procured by the SPO specifically for the A-10 and have design-to-cost contractual

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[7]Headquarters, Air Force Systems Command, Andrews AFB, Maryland. Interviews with personnel assigned to the DCS/Procurement and Production. October 1973

provisions. The fourth subsystem is the avionics package which is being procured for the A-10 by a separate program office. It is virtually an off-the-shelf subsystem which has a more easily determined cost figure than the subsystem being built specifically for the A-10.

Fairchild Republic Division, Fairchild Industries Incorporated, Farmingdale, New York, is the prime contractor with contractual responsibility for designing and building the air vehicle and integrating all of the subsystems into a total system. The engine for the A-10 is being procured from the Aircraft Engine Group, General Electric Company, Lynn, Massachusetts, and the 30 millimeter gun is being designed and manufactured by the Armament Department, General Electric Company, Burlington, Vermont.

The contracts for each of these subsystems were let by the A-10 SPO and each includes a design-to-cost clause as a special feature of the contract. All three contracts are cost type contracts with incentive provisions. Each has a fixed price provision for option to buy additional test aircraft and long leadtime spare parts for the production phase. A single work breakdown structure is called out in each contract. Other contractual provisions and clauses are nearly the same in these contracts.

There are numerous design and production features in the airplane which resulted from the strong emphasis on cost control. The contractual provisions affecting the design-to-cost objectives are rather unique in their application and interaction to strengthen

the contract. An examination of the design-to-cost clause in the A-10 contracts would be appropriate at this point.

THE CLAUSE

The design-to-cost clause terminology in the contracts for the air vehicle, engine and gun subsystems is similar yet peculiar to the particular contract. Each contract uses the "unit production flyaway cost" term. According to the draft Joint Design-to-Cost Guide, only the integrating contract, which also includes the air vehicle, should refer to unit flyaway cost. The contracts for the other subsystems should refer to unit production cost. For clarity, the contract with Fairchild should separately identify the unit flyaway cost for the total system and the unit production cost of the air vehicle.

In other respects, the three design-to-cost clauses are almost identical. Dollar amounts and products are the only differences. So, for the purpose of this discussion only the contract with Fairchild will be discussed because of the design, manufacture and integration responsibilities in their contract. Reference to the other contracts will be made when appropriate.

In the contract with Fairchild, unit production flyaway costs are defined as the sum of all recurring and non-recurring costs (excluding all research, development, test and evaluation costs) necessary to produce a complete aircraft, including the applicable portion of system engineering and program management dollars. The recurring costs include the airframe, propulsion, electronics,

armament, contractor furnished equipment and government furnished aeronautical equipment costs plus engineering change orders which are needed to meet system specification requirements. Non-recurring costs are for the duplication tools and production engineering required to attain a specific rate of production. This also includes any engineering change order dollars appropriately categorized as non-recurring.[8]

It is apparent from this description of unit production flyaway costs that they include only a portion of the total life cycle costs. The major exclusions are RDT&E costs plus operation and maintenance costs. Also excluded are costs associated with the production of aerospace ground equipment, training, data, initial spares and the applicable portions of system engineering and program management.

The specific design-to-cost goal as called out in the Fairchild contracts is to "design to a cumulative average production flyaway cost of $1.5 million expressed in 1970 dollars for a total of 600 aircraft produced at a rate of 20 aircraft per month."[9] There are several key points included in this objective which should be discussed further.

First, inflation will not affect the goal since it is expressed in 1970 dollars. This is important since the first production

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[8]Contract between Aeronautical Systems Division, Air Force Systems Command and Fairchild Republic Division, Fairchild Industries Incorporated, F33657-73-C-0500, January 1, 1973.

[9]Ibid

aircraft is currently scheduled to be rolled out in November 1975 with the 600th roll out to come in early 1978.[10] It would have been unrealistic to ask Fairchild to accurately predict inflation rates for eight years in advance, therefore the constant dollar restriction.

Second, a fixed rate of production is stipulated. Producibility considerations made by the Fairchild design team during the conceptual phase were based on an economical production rate of 20 aircraft per month. Any perturbation to the program which affects this production rate would undoubtedly affect the design-to-cost goal.

Third, 600 aircraft must be produced and their costs averaged to compare against the objective. The rate stipulation and production run requirement reflect a heavy emphasis on producibility which must be addressed in product design and preproduction planning. Also, a production run requirement places emphasis on the design-to-cost goal over a longer period in the acquisition cycle.

Fourth, the $1.5 million figure stipulated in the Fairchild contract includes the design-to-cost dollar goal for the air vehicle and other subsystems of the aircraft which are contracted for separately by the A-10 SPO. Fairchild also has a number of sub-contractors on the airframe. Any of these separate contractors could affect the total design-to-cost (unit flyaway cost) goal.

Lastly, the dollar objective includes a reserve for engineering

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[10]Ibid

change orders. Changes to the design are inevitable. This means more dollars for engineering and possible new material requirements. A tight control on all changes must be applied by the A-10 Program Office to make design-to-cost work. The contractor must control the producibility and internal management aspects throughout product development. Any one or combination of these forces can cause the contractor to not meet his design-to-cost objectives.

The contractor's cost/schedule control system is used to identify the areas of change from the original development plan and serves as a tracking vehicle to ascertain the effects of any development change, business base change or other change to the design-to-cost goals. The proposed budgetary estimates for his portion of the unit flyaway cost serve as the baseline against which deviations are reported. Changes of $3,000 or more to the baseline must be reported in the Monthly Cost Performance Report showing the effect on the then year dollars and the FY1970 dollars. An analysis of the effect of these changes is also reported along with the contractors proposed corrective actions or trade-offs to bring the cost within the limit of the established objective.[11]

RELATIONSHIP WITH OTHER CLAUSES

There are a number of special clauses incorporated into the A-10 contracts. These clauses call out the limitations of government obligations, options, award fee provisions, charging and allocation of costs, system integration responsibilities and demonstration

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[11] Ibid

milestones. The later three clauses have a marked effect on the design-to-cost goals.

Costs applicable to the design-to-cost goals for an A-10 must be separately collected, recorded and reported. The charging and allocation of costs clause specifies the separation of these costs from the other RDT&E and production costs. This is an essential administrative procedure. Reporting of these costs is covered under the contractor's validated cost schedule control system.

The total system integration responsibility (TSIR) clause makes Fairchild responsible for the entire $1.5 million design-to-cost goal. As pointed out earlier, this encompasses a number of contractors who supply subsystems and components to the prime contractor. This clause is distinctly different from a similar total system performance responsibility (TSPR) clause used in other major weapon system contracts. Under a TSPR clause, the prime contractor is responsible for insuring that all government furnished equipment (GFE), when installed and integrated into the prime system, functions so that the total system meets its performance specifications. Fairchild must accept and integrate all GFE but is only responsible for insuring that the GFE performs to its specifications not the total system specifications. This is a fine line and was discussed at some length during the validation phase. Based on these discussions, the TSIR clause was included in the full scale development contract presumably to help keep the unit flyaway cost down.

Demonstration milestones are called out in the contracts for several aspects of the program and specifically for two design-

to-cost reviews. These reviews occur at the same time as the critical design review (March 1974) and at the time the eighth test aircraft is to be delivered (August 1975).[12] At each review, the prime contractor must demonstrate that the design-to-cost goals can and will be met. These reviews may end up being mini-DSARCs, because program continuation will be based on the reported status. This provision in the contract is probably a direct result of the DOD requirement for a demonstration of the realism of the plan for the remainder of the program. This feature is supported by many as an excellent tool to encourage design excellence which in turn works toward minimizing production costs.

Other clauses in the contract including those previously mentioned could affect the contractors ability to meet his design-to-cost objectives. For example, if the contractor does not forecast his funds requirements adequately in accordance with the limitation of government obligations clause, sufficient dollars may not be available to satisfy his requirements during a particular fiscal year.

The life cycle cost clause must be compatible with the dollar recording and reporting requirements of design-to-cost. Trade-offs in performance to reduce the unit costs should also be considered as to just how they affect the life cycle costs. These changes in design should be made only if they reduce both the unit cost and life cycle costs.

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[12]Ibid

A clause which has little effect on the design-to-cost provisions is the award fee clause. In the contract with Fairchild, it applies only to minimizing logistic effects associated with the contract options for additional aircraft. There is no correlation between meeting design-to-cost goals and the fee awarded to the contractor. Possibly this type clause could have been structured to give additional incentives to meet the design-to-cost goals. The primary incentive presently in effect is the possible termination of the contract if the goals are not satisfactorily met.

OTHER CONSIDERATIONS

Design-to-cost provisions should be used only on contracts for moderately complex products that are intended for eventual large quantity buys. This appears self-evident in that the more complex product the more difficult it is to determine the unit production and flyaway costs. However, the design considerations that are associated with design to a specified cost may be incorporated even in the more complex programs.

The design-to-cost provisions should be stipulated in the request for proposal (RFP) issued for the conceptual phase effort. Unless this requirement is stipulated early in the design effort, it may be more difficult to incorporate and will probably have less effect on the design. The design efforts by Fairchild were focused entirely on their design-to-cost objectives. Their small team of design and production type people were continually apprised of the days remaining to first flight of their design-to-cost prototype.

Maintainability, along with reliability, are major areas of design concentration in most programs today. It is even more important that these two disciplines become major considerations in contracts incorporating design-to-cost features. When incorporated in the design process, maintainability and reliability will force the unit production cost down and should cause a reduction in operation and maintenance costs thereby reducing life cycle costs.

The fly-off between the A-10 and A-7 that has been proposed by Congress may well slip the schedule a few months. If more time is required in full scale development to engineer and test the weapon system, then production will be later in starting. As long as the slippage does not affect the monthly production rate, there should be little affect of this additional out of scope test upon the design-to-cost goals. It is a rather unusual requirement imposed upon the program at this time.

CONCLUSIONS

It is of major concern within the DOD that the emphasis on design-to-cost become a general attitude or way of life in considering cost rather than a specific technique. They are specifically concerned that the current DOD interest not precipitate a new "ility" or cult with accompanying specifications. Any thought of paying lip service to designing-to-cost is at a polar extreme from the stated DOD attitude on this subject.[13]

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[13]Lt General Robert E. Coffin. "Design to Cost: Department of Defense Concepts", Army Research and Development News Magazine, Vol. 14, No. 5 (September-October 1973), p. 1

The contractual application of this concept is becoming more standardized. Publication of the Joint Logistics Commanders (JLC) Guide on design-to-cost will be an immeasurable aid toward this end. Terminology, conditions for use, management review procedures and incentive provisions should be standardized to some degree within the DOD. The A-10 program contracts appear to reflect at least the JLC position on just what design-to-cost is supposed to be and how it is to be used. It is quite possible that the A-10 program contracts were used as a model for writing the JLC guide.

Incentives for achieving design-to-cost goals could possibly be incorporated within the contract clauses using an award fee or made a part of the cost or performance incentive structures. This would be especially true if only one contractor were involved when the design-to-cost goals are contractually incorporated in a program. If competitive prototyping or design is also included in the procurement plan at the time design-to-cost is included in the contracts, then this technique will probably provide sufficient incentive for the contractors to pursue their design goals and other contractual incentives would be unnecessary. The competition strategy has apparently worked on the A-10 program.

Incorporation of the design-to-cost goals in the early acquisition cycle RFP's is a must. Design teams can work toward these goals if they are known early enough. Attempts to include a design-to-cost provision at later phases in the product acquisition can possibly

serve to place a dollar ceiling on the unit cost at the time of incorporation and could possibly affect producibility decisions concerning rates, tools and procedures.

The responsibility for total system integration rather than total system performance is another key contractual feature in applying the design-to-cost concept. It may be difficult or far to expensive for a contractor to agree to the later and accept design-to-cost restrictions as well. Total system integration responsibility is a minimum supportive contractual feature.

Incorporating a unit cost, production rate and run sizes and constant dollar goals are basic to the design-to-cost concept. Contractually enforcing these requirements appears to be feasible and is acceptable to industry. Design-to-cost reviews or milestones are also essential to check the realism of the contractors progress toward meeting the specific goals.

Design-to-cost can be a viable contractual tool as well as a major engineering goal. The contractual application must support the program goals.

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